
# Voltage Sensors

## Voltage Sensor

*Product No. 3162*
Range: ±1 V
Resolution: 1 mV

## Voltage Sensor

*Product No. 3161*
Range: 0 to 10 V
Resolution: 10 mV

## Voltage Sensor

*Product No. 3160-12*
Range: ±12 V
Resolution: 10 mV

## Voltage Sensor

*Product No. 3160*
Range: ±20 V
Resolution: 10 mV

DATA HARVEST

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**DS 021** ***No 4***

## Contents



## Introduction

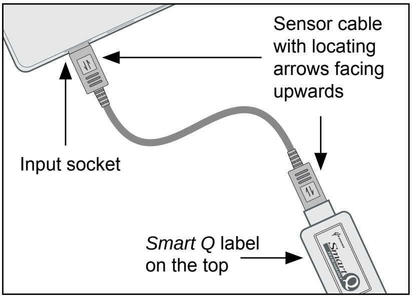
The *Smart Q* Voltage Sensors are used to measure the potential difference between the ends of an electrical component. This range of Voltage Sensors can be used to measure both DC and low-voltage AC circuits.

**SAFETY !** Never use high voltages or household AC

The *Smart Q* Voltage Sensors are equipped with a micro controller that greatly improves the sensor accuracy, precision and consistency of the readings. They are supplied calibrated and the stored calibration (in volts) is automatically loaded when the Voltage Sensor is connected.

## Connecting

1. Hold the Voltage Sensor housing with the *Smart Q* label showing on the top.
2. Push one end of the sensor cable (supplied with the **EASY**SENSE unit) into the shaped socket on the sensor housing with the locating arrow on the cable facing upwards.
3. Connect the other end of the cable to the input socket on the **EASY**SENSE unit (with the locating arrow facing upwards).

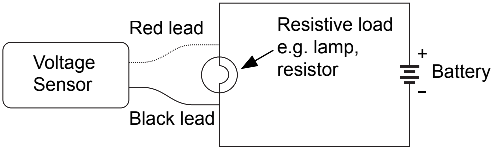



4. The **EASY**SENSE unit will detect that the Voltage Sensor is connected.

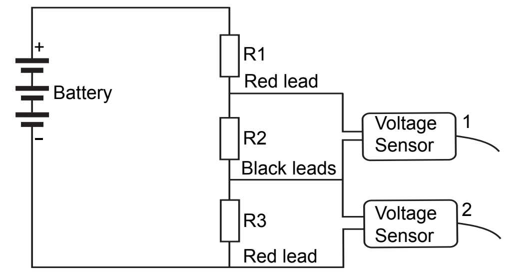
## Practical information

Voltage, referred to as potential difference or electromotive force (emf) is the electrical potential energy between two points in a circuit and is the driving force pushing the electricity around a circuit.

- The Voltage Sensor is used to measure the potential difference between the ends of an electrical component and is therefore connected across (i.e. in parallel) the component.




- Make sure you observe the correct polarity i.e. connect the black lead from the Current Sensor to the negative terminal of the cells.
- Voltage Sensors can be used in conjunction with a Current Sensor anywhere in a circuit.
- For reasons of accuracy, if more than one Voltage Sensor is being used in a circuit, ensure they share a common earth (the same black lead).



An example of using two Voltage Sensors in the same circuit

**Note:** *In this circuit the reading from Voltage Sensor (2) will be negative. To correct to a positive value use the Tare pre or post log function and set the tare value to -1 (see page 3).*

- Product No 3160 (±20V), 3160-12 (±12V) and 3162 (±1V) can be used to measure both negative and positive potentials.

  The range for Product No 3161 (0 - 10V) was selected so that only positive potentials are displayed. It has the same resolution as the 3160 and 3160-12 Sensors.

- If a Voltage Sensor is connected to an **EASY**SENSE unit, without being part of a complete circuit, then data collected may appear 'noisy'. To measure voltage accurately you need high impedance (resistance), the Voltage Sensor is a high impedance device and will pick up any electrical 'noise'.

**Note:** *To demonstrate zero impedance, short out a Voltage Sensor by connecting its black & red plugs together.*

- Batteries are the first choice as the source of energy. An alternative to batteries is to use a fully isolated mains power supply with a regulated DC output (smoothed and fully rectified).

  Be aware that some power supplies are ½ wave rectified producing an average rather than true DC. The Voltage Sensor will ‘pick up’ the fluctuations in voltage and current from this type of power supply.

## Specifications

| **Product Number** | **3162** | **3161** | **3160-12** | **3160** |
|---|---|---|---|---|
| **Range (V)** | ±1 | 0 to 10 | ±12 | ±20 |
| **Resolution (mV)** | 1 | 10 | 10 | 10 |
| **Protected to a maximum voltage (V)** | ±10 | ±27 | ±27 | ±27 |
| **Impedance (Meg ohm)** | 1 | 1 | 1 | 1 |

## Subtracting an offset

If you want to change the sign of a number or subtract an offset from a Sensor’s reading (i.e. when the reading isn’t exact zero) use the Tare pre or post-log function.

**Note:** *Use the Pre-log function for the tare to be applied to the data as logging progresses or the Post-log function to apply the tare to data that has already been recorded.*

- If subtracting an offset, first select **Test Mode** from the **Tools** menu to find the tare value and then click on **Stop**.
- Select **Pre** or **Post-log function** from the **Tools** menu.
- Select a **Preset** function, with **General** from the drop-down list and then **Tare** from the second list, Next. Select the Voltage Sensor as the Channel, Next. Enter a name for the corrected data set e.g. Voltage (adj.) and enter the **tare value**. Click on Finish.

## Calculating Resistance or Power

A Pre or Post-log function can be used to calculate Resistance or Power from Current and Voltage data.

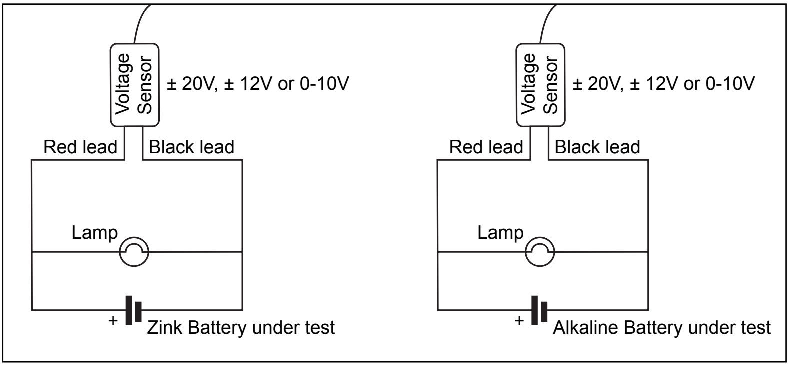
- Select **Pre** or **Post-log function** from the **Tools** menu.
- Select a **Preset** function, with **Electricity** from the drop-down list and then **Calculate Resistance** or **Calculate Power** from the second list, Next.
- Select the Voltage and Current channel to use, Next.
- Enter the appropriate multiplier using the information supplied in the white panel. Click on Finish.

# Investigations

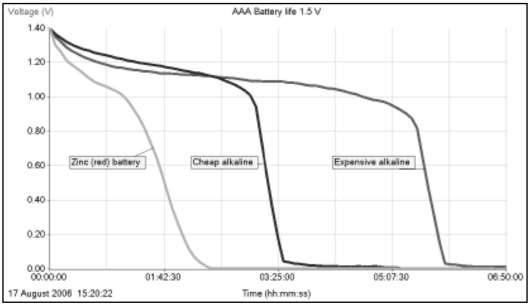
- *Battery life*
- *Series and parallel circuits*
- *Ohm's law*
- *Alternative power investigations e.g. solar cells*
- *Heat and electric current*
- *Induction of a voltage in a coil, and what happens when a magnet spins in a coil?*
- *Electrical component characteristics*
- *Power*
- *Investigating a thermistor, light dependent resistor*
- *Start up current of a light bulb*
- *To measure the voltage from a homemade sensor*
- *Time constant, charge and energy stored in a capacitor*

## Which battery is the best buy?

In this experiment the difference between the power outputs from different makes of battery are tested.




1. Assemble the apparatus as shown with the Voltage Sensors connected to the **EASY**SENSE unit.
2. Select EasyLog and record until the lamp goes out. The length of time this will take will depend on the size of the battery selected e.g. for a 1.5 V AAA battery it took between 2 - 6 hours.




In the example shown three circuits were used, each with a single AAA battery and a 2.5 volt bulb. The graph has been Auto scaled 0 to Max. The results could be used to calculate which battery is better value for money.

Extension Ideas: -

- Compare different types & makes of batteries.
- Compare difference sized batteries with the same voltage, i.e. AAA, AA, C, D size 1.5V batteries.
- Use a Light Level Sensor to record the brightness of the lamps as the power from the battery is used up.

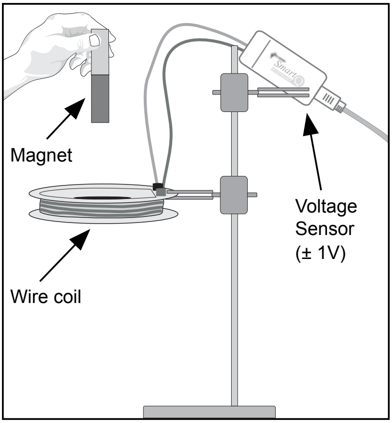
## Magnetic induction

This investigation measures the voltage induced by a magnet falling through a wire coil.

**Note:** *This investigation is only suitable for an* ***EASY****SENSE unit capable of fast logging.*

Use the ±1 V Voltage Sensor - *Product No. 3162.* The Wire Coil used is a *Smart Q* Accessory - *Product No. 3173.*

**Note:** *You can use the ±12 or 20 V sensors but the resolution and therefore the graph will not be as good. The trigger level with these Sensors should be set to volts e.g. rises above* ***0.4 V.***



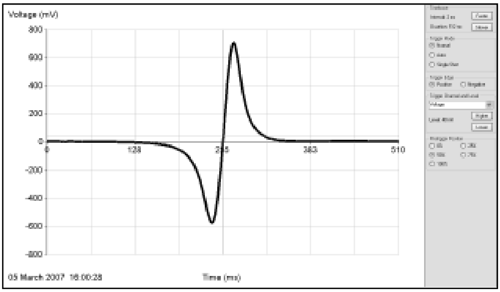

If you are using your own wire coil connect a 0.01µf ceramic capacitor across the coil terminals to reduce emf noise.

1. Assemble the apparatus as shown with the Voltage Sensor connected to the **EASY**SENSE unit.
2. Open the **EASY**SENSE program and select either Scope or Graph from the Home page. Set the options for recording the data (see suggestions in the table).

| **Scope** | |
|---|---|
| Interval | 1 ms, **2 ms**, 5 ms |
| Trigger mode | Normal or Single shot |
| Suggested trigger level | Positive 40 mV with a 50% pre-trigger |

| **Graph** | |
|---|---|
| Total recording time | **500 ms,** 1 s, 2  s |
| Interval between samples | **500 us,** 1 ms, 2 ms |
| Suggested trigger level | Rises above 40 mV with a 50% pre-trigger |

In this graph Scope was used to collect data with a 2 ms interval, normal trigger mode, positive edge, at a level of 40 mV with a 50% pre-trigger.




3. Click on **Start**.
4. Mark one end of the magnet and drop this end through the coil.

Extension Ideas:

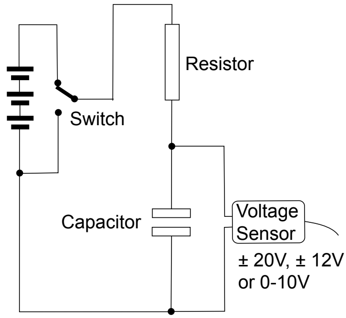
- What happens when the magnet is dropped through unmarked end first?
- Try using longer or shorter magnets or dropping from different heights.
- Join two magnets together, firstly with poles attracting, secondly with poles opposing.
- Suspend the magnet horizontally from a coiled up elastic band so it can spin clockwise and anticlockwise close to the Wire coil - to create the dynamo effect.

## Capacitor discharge and charge

This investigation measures the voltage across a capacitor as it discharges and charges.

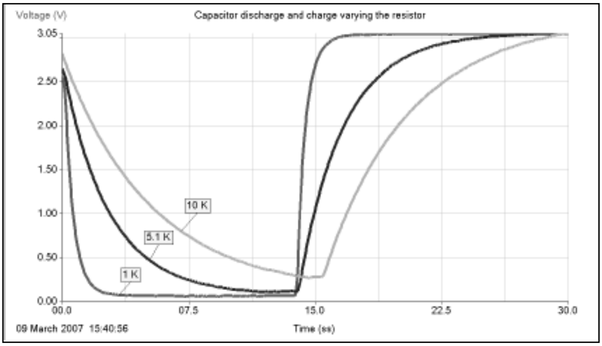
**Note:** *To select the appropriate capacitor and resistor, use the formula T = CR, where T = time in seconds, C = capacitor value in farads, R = resistor value in ohms.*

1. Assemble the apparatus as shown with the Voltage Sensor connected to the **EASY**SENSE unit.
2. Open the **EASY**SENSE program and select **Meters** from the Home page. Fully charge the capacitor (until the value stops rising) and measure the potential difference. This value will be used to set a level for the trigger.
3. Click on Stop and select the **Home** page icon.



4. Select **Graph** and in the logging wizard select a time span of 30 seconds and a trigger for when the value falls just below the potential difference level measured in step 2.
5. Select **Test Mode** from the Tools menu, short out the capacitor - wait until it is fully discharged (value stops falling).
6. Fully charge the capacitor (until the value stops rising).
7. Click on **Start**, move the switch to allow it to **discharge** for about 15 seconds and then switch over again to charge for the rest of the recording time.
8. Change the resistor to a different size. Select **Overlay** and repeat.

In the example shown a 470 μF capacitor was used with a 1 K, 5.1 K, 10 K resistor. The use of a trigger means each data set starts at the same value.

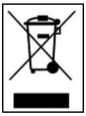



## Warranty

All Data Harvest Sensors are warranted to be free from defects in materials and workmanship for a period of 12 months from date of purchase provided they have been used in accordance with any instructions, under normal laboratory conditions. This warranty does not apply if the Sensor has been damaged by accident or misuse.

In the event of a fault developing within the 12-month period, the Sensor must be returned to Data Harvest for repair or replacement at no expense to the user other than postal charges.

**Note:** *Data Harvest products are designed for* ***educational*** *use and are not intended for use in industrial, medical or commercial applications.*



WEEE (**W**aste **E**lectrical and **E**lectronic **E**quipment) Legislation

Data Harvest Group Ltd are fully compliant with WEEE legislation and are pleased to provide a disposal service for any of our products when their life expires. Simply return them to us clearly identified as 'life expired' and we will dispose of them for you.